Extra

Electromagnetic Engineering (EC21006)
Mid Semester Examination
Department of Electronics and Electrical Communication Engineering

Full Marks : 60
Time – 2 hrs

Answer all questions. The marks for the individual questions are indicated on the right.

1. The permittivity, permeability and conductivity of a medium are given by : $\varepsilon = 1.2\times10^{-10}\,F/m$, $\mu = 3\times10^{-5}\,H/m$ and $\sigma = 0$ respectively. The medium is excited with a magnetic field $\vec{H} = 2\cos\left(10^{10}t - \beta x\right)\hat{a}_z\ A/m$. Obtain the field components $\vec{B}, \vec{D}$ and $\vec{E}$ and the value of β. (10)

2. The relative permittivity and conductivity of a medium are given by : $\varepsilon_r = 1$ and $\sigma = 0$ respectively. If the magnetic field in the medium is $\vec{H} = 4\sin\left(10^6 t - 0.01z\right)\hat{a}_y\ A/m$, determine the electric field and the relative permeability μ_r of the medium. (10)

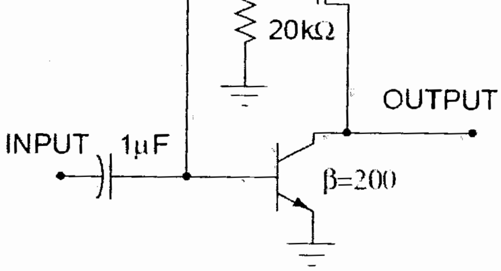
3. A voltage source $v(t) = 10\cos(\omega t)$ is connected across a parallel plate capacitor filled with polystyrene ($\varepsilon = 2.56\varepsilon_0, \sigma = 3.7\times10^{-4}\,S/m$) between the plates. Assuming a plate separation of 2 cm with no field fringing, determine the maximum values of the conduction and displacement current densities within the polystyrene at the frequencies 1 MHz and 100 MHz. Comment on the results. (10)

4. The electric field $\vec{E}$ in a nonmagnetic medium is given by $\vec{E} = 4\sin\left(2\pi\times10^7 t - 0.866y - 0.5z\right)\hat{a}_x\ V/m$. Compute the following :

   (a) The relative permittivity ε_r and the intrinsic impedance η of the medium. (b) The time average power flow. (c) The total power crossing 100 cm^2 of the plane $2x + y = 5$. (15)

5. Derive and explain the power conservation theorem for instantaneous electromagnetic fields. (15)

factor, λ = (1/70) V^{-1}. Values of the remaining parameters can be taken as that of ideal one. Similarly, for the n-p-n transistor, the Early voltage, V_A = 50V and values of the remaining parameters can be taken as that of ideal one.



(a) Find the value of the resistor R so that I_{CQ} = 2.02 mA and V_{CEQ} = 5V. Use this value of R for the subsequent parts of this question.

(b) Draw small signal equivalent circuit of the amplifier.

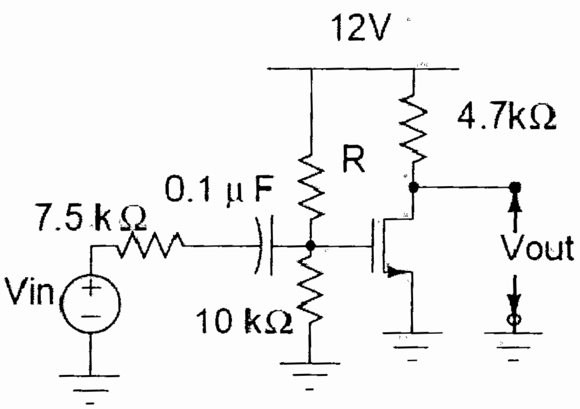
(c) Find the small signal gain of the amplifier.

(d) If you cascade two identical such amplifiers what will be the overall voltage gain

[3 + 3 + 3 + 6 = 15]

Q. 3. A common source amplifier circuit is shown in the adjacent figure. Values of some parameters of the transistor are the following: Transconductance factor, K = 1mA/V^2 ; Threshold voltage, V_{Th} = 2 V; Channel length modulation factor, λ = 0.01 V^{-1}. Values of the remaining parameters can be taken as that of ideal one.

(a) Find the value of the resistor R such that I_{DSQ} = 1mA.



(b) With the value of R that is obtained in the part (a) of this question, find the small signal voltage gain of the amplifier in mid-frequency range.

(c) With the value of R that is obtained in the part (a) of this question, find the maximum output signal swing without having “significant distortion”.

(d) With the value of R that is obtained in the part (a) of this question, find the lower cutoff frequency of the amplifier.

(e) With the value of R that is obtained in the part (a) of this question, for V_{in} = 500 Sin((2000/3)t) mV, neatly sketch the output voltage V_{out}.

[3 + 3 + 3 + 3 + 3 = 15]